

AESTIVATION OF TURTLES IN KEOLADEO NATIONAL PARK, BHARATPUR WITH SPECIAL REFERENCE TO *LISSEMYS PUNCTATA* (REPTILIA : TRIONYCHIDAE)¹

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(With a text-figure)

Key words: *Lissemys punctata*, aestivation, critical temperature, Bharatpur

The aestivation of the Indian flapshell turtle, *Lissemys punctata* was studied in Keoladeo National Park, Bharatpur between January and June 1987. Plots were laid in dried up marshes to locate and study the aestivating turtles. *Lissemys punctata* spent about 160 days in aestivation and the aestivation depth of the turtle varied from 2 to 10 cm with a mean of 5.20 cm (n = 304). Bushes near the drying water body had the highest concentration of 166 turtles/ha. Overall, the highest density of aestivating *Lissemys punctata* (75 turtles/ ha) were observed within 50 m radius of the drying water body. Diurnal substratum temperature in the aestivating habitats varied from 28° to 48°C.

INTRODUCTION

Ecological studies on Indian freshwater turtles are few. The Indian flapshell turtle, *Lissemys punctata* is one of the most wide spread turtle species of the Indian subcontinent and inhabits ponds and shallow waterbodies (i.e. non-perennial/ fluctuating habitats). Despite its commonness, only some aspects of its biology have been worked out. Most reptiles reduce their activity during extreme climatic conditions and undergo hibernation or aestivation. This is one of the physiological strategies for surviving and for avoiding predators. It is reported that apart from desert reptiles, many tropical and temperate forms such as turtles burrow and remain dormant until rain occurs (Gregory 1982). Some species such as the American mud turtle, *Kinosternon subrubrum* travel overland during summer in search of suitable aestivation sites when waterbodies dry (Bennett *et al.* 1970). However, studies on the terrestrial activity of aquatic turtles are scanty and restricted to Western countries. This study examines the aestivation behaviour of *Lissemys punctata*. The following aspects were covered; aestivation habitat, duration, depth and substratum temperature. The study was conducted in Keoladeo National Park (KNP), Bharatpur between January and June 1987, when the Park experienced severe drought.

METHODS

The K.N.P., Bharatpur is a non-perennial wetland situated in the flood plains of the rivers Banganga and Gambir. The total area of the Park is 29 sq. km and the aquatic area during winter is about 8.5 sq. km. During summer, especially in drought years, water spread recedes to a few hectares exposing aquatic fauna to severe predation. Detailed information on the flora and fauna of the Park is available elsewhere (Vijayan 1987, 1991).

Plots of varying size (c. 50 x 50 m) were laid throughout the dried aquatic area and intensely searched for aestivating turtles. A stick with a pointed metal tip was used in locating the buried reptiles. Burrowing turtles in drying marsh were located by the presence of a breathing hole and in grass and other habitats by the disturbed nature of the surface. The following details were recorded at each location of an aestivating turtle: (1) name of the species, (2) microhabitat and (3) aestivation depth (from soil surface to the carapace of the aestivating turtle). Microhabitat classification was based on the plant cover and moisture content in the soil. A digital thermometer was used to record the atmospheric and substratum temperature of the turtle aestivation site. Temperature was recorded every hour from 0600 to 1800 hrs for two days in the first half of June 1987 to determine the temperature tolerance of *Lissemys punctata*. The aestivating turtles were also monitored to record the aestivation duration.

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RESULTS AND DISCUSSION

AESTIVATION OF *LISSEMYS PUNCTATA*

Turtle fauna of the Keoladeo National Park, Bharatpur: Seven species of freshwater turtles have been recorded from KNP, Bharatpur. They are, 1. Indian flapshell turtle (*Lissemys punctata*), 2. Indian softshell turtle (*Aspideretes (Trionyx) gangeticus*), 3. Indian peacock softshell turtle (*A. hurum*), 4. indian roofed turtle (*Kachuga tecta*), 5. Indian tent turtle (*K. tentoria*), 6. Crowned river turtle (*Hardella thurjii*) and 7. Spotted pond turtle (*Geoclemys hamiltonii*). The first three species are softshells and remaining are hardshells.

Turtle aestivation in K.N.P., Bharatpur: A total of 7.9 ha were surveyed and 319 aestivating turtles were recorded. All species, except *K. tecta* and *K. tentoria* were recorded in the survey plots. However, turtles of all species, except *Lissemys punctata* stayed temporarily in the drying mud and they either deserted their aestivation site or were found dead after about one month (Table 1). *Lissemys punctata* stayed in the aestivation site until normal conditions returned (i.e. till the monsoon). Hence, only *Lissemys punctata* should be considered as a truly aestivating species in the KNP, Bharatpur. *Kachuga* spp. are basically riverine species which could be the reason for not aestivating. Aestivation of *Lissemys punctata* inhabiting semipermanent waterbodies has already been reported by Daniel (1983). Similar to *Lissemys punctata*, aestivation has been reported in the American mud turtle, *Kinosternon flavescens* (Seidel 1978).

Aestivation habitat: In KNP, Bharatpur five types of turtle aestivation habitats was distinguished during the present study. They were bushes, *Eicchornia*, grass, soft mud and dried mud. The distribution of the grass habitat was throughout the study area, whereas the other habitats were restricted mostly within 50 m of the vicinity of water. Hence, turtles observed in a 50 m radius from the existing water body were taken for analysis. Among the five habitats recorded, grass was the commonest (40.5%) and soft mud the least (1.78%). The area surveyed in each habitat type is given in Table 2. A total of 304 aestivating *Lissemys punctata* were recorded in the intensive survey plots (i.e. in 7.9 ha). About 82% (249) of the turtles were recorded in the plots of 50 m radius of the last remaining waterbodies which accounted for 3.33 ha (42.2%) of the sampled area.

A high density of aestivating turtles, 950 turtles/ha was recorded in the soft mud habitat (Table 2). This was a temporary habitat and in due course, this dried mud became unsuitable for aestivation. Aestivating turtles in the soft mud deserted this habitat when it became dry and lost moisture drastically and cracked. No cover was available and aestivation in open dried mud in such a concentration seemed risky, as an efficient predator can easily find the hiding prey (Bennett *et al.* 1970). Hence, turtles aestivating in this habitat might have abandoned it when it dried up.

The more stable habitats such as bushes adjacent to the drying marsh had the highest density

TABLE 1
TURTLE AESTIVATION IN KEOLADEO NATIONAL PARK,
BHARATPUR

Turtle species	Number recorded	Mean aestivation depth (cm)	Maximum aestivation (in days)
<i>Geoclemys hamiltonii</i>	1	1	23 (1)
<i>Hardella thurjii</i>	9	3.63	32 (9)
<i>Trionyx</i> spp.	27	11.87	49 (5)
<i>Lissemys punctata</i>	304	5.20	160 (20)

No. in parenthesis is number of turtles monitored.

TABLE 2
DENSITY OF AESTIVATING *Lissemys punctata* IN THE
VICINITY OF 50 M OF EXISTING WATER

Habitat	Area	Aestivating turtle Number	Density
Bushes	0.410	68	166
<i>Eicchornia</i>	0.761	57	75
Grass	1.361	67	49
Slushy mud	0.060	57	950
Dried mud	0.740	0	-

of 166 *Lissemys punctata* per ha. This is mainly because, these habitats had sufficient moisture and cover which saved the turtles from desiccation and predation.

Aestivation duration and site fidelity: After selecting a suitable aestivation site, turtles stayed there for the rest of the dry season. *Lissemys punctata* is adapted to xeric conditions and was observed aestivating for more than 160 days (Table 1). Other species mostly abandoned or were found dead in the aestivation site within a month, indicating that turtles other than *Lissemys punctata* are not adapted for aestivation or to withstand prolonged drought conditions. Bennett *et al.* (1970) report that *Kinosternon subrubrum* left aestivation sites within 5-7 days in search of new sites.

Among the turtles recorded in KNP, only *Lissemys punctata* is adapted to fluctuating or semipermanent habitats (i.e. ponds, shallow water bodies, etc.) and changing water conditions. *Lissemys punctata* was observed emerging out of the drying water body well before the pond disappeared. However, other species did not leave the water till the water body became totally dry. *Lissemys punctata* is a moderate sized turtle and prone to higher predation. Hence, aestivation during dry season would be beneficial for *Lissemys punctata* to protect itself from heat (desiccation) and predators. Other species recorded in K.N.P. are two *Aspideretes* spp. (softshells) which are larger in size and the remaining are hardshells and might have higher chances of survival from avian predators while staying in a drying waterbody. Also, *A. gangeticus* was observed feeding on *Lissemys punctata* during summer when the water level was low (Bhupathy 1990). The White scavenger vulture (*Neophron percnopterus*) has been recorded as a major predator of *Lissemys punctata* in K.N.P. (Bhupathy and Vijayan 1989). Also, herons, storks, jackals and stray dogs fed on turtles in this study area.

Aestivation depth: *Lissemys punctata* buries itself in a suitable substratum for aestivation till the next monsoon. The depth varied from 2 to 10 cm with a mean of 5.20 cm

TABLE 3
RELATIONSHIP BETWEEN DISTANCE FROM THE EXISTING
WATER BODY AND AESTIVATING *Lissemys punctata*

Distance (Metre)	Area (ha)	Aestivating turtle	
		Number	Density
<50	3.33 (42.2)	249 (81.9)	75
100	1.61 (20.5)	26 (8.5)	16
200	1.47 (18.6)	25 (8.2)	17
300	0.86 (11.0)	4 (1.3)	5
400	0.61 (7.7)	0	-

Number in parentheses are percentage.

(n = 304, Table 1). Auffenburg (1981) and Das (1991) have recorded this depth as 3-6 cm. There appears to be a relation between the neck length and aestivation depth of turtle species. The turtle species having the longest neck (in the study area), *Aspideretes* spp. buried themselves deep in the soil (i.e. 12 cm) as against the short necked hardshells 1-3 cm (Table 1).

Turtle aestivation and distance from drying water body: The highest density of aestivating turtles was recorded within a 50 m radius of the last remaining waterbodies. As the distance increased, the density of aestivating reptiles decreased (Table 3). At about 400 m aestivating turtles were not recorded. This might be due to the fact that whenever turtles emerged from a drying water body (i.e. 0 m), they were immediately attacked by predators such as the White scavenger vulture (Bhupathy and Vijayan 1989). Hence, turtles were forced to aestivate nearby drying marsh and had no chance to move far away. This is supported by the fact that about 75% of the predation on this species was observed within 100 m of a drying waterbody (Bhupathy and Vijayan 1989). However during monsoon, turtles were observed emerging from woodland forest, which was about one kilometer away from the last remaining water body. This may have resulted from crepuscular or nocturnal movement overland of some turtles when most of its predators are inactive.

Turtle aestivation and temperature: Diurnal temperature monitored in the aestivation sites of turtles in different habitats showed that in the early

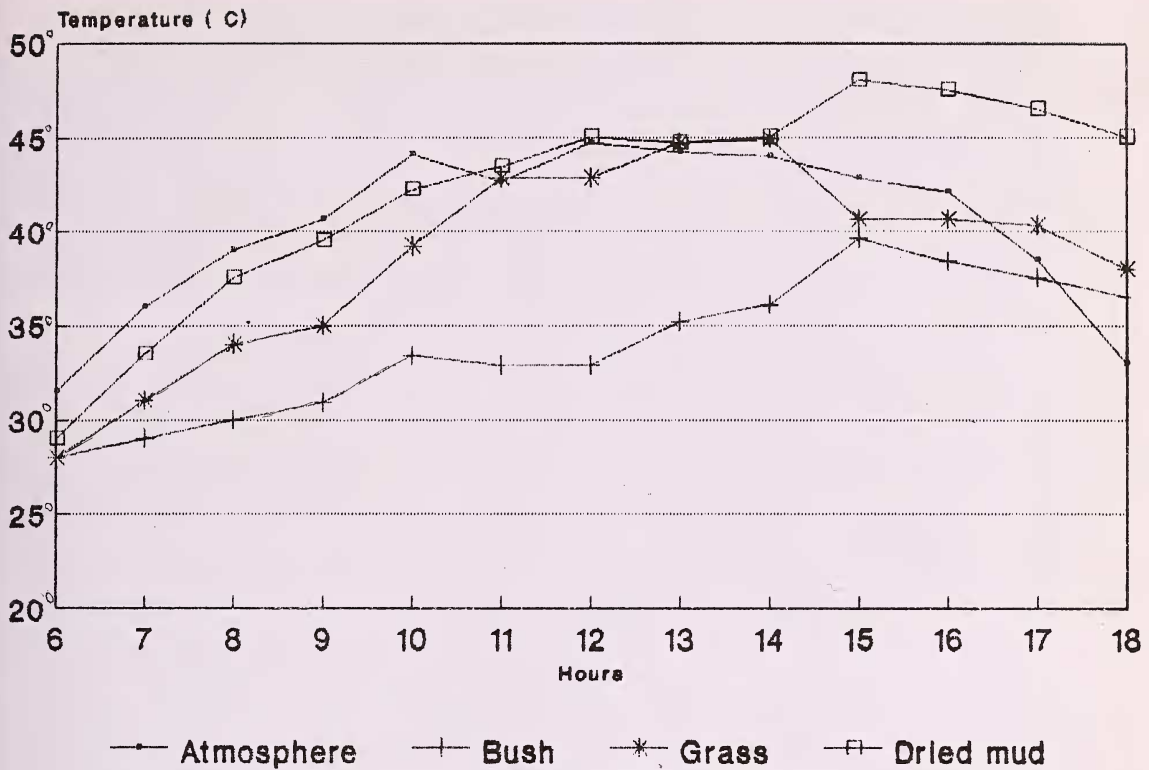


Fig. 1. Temperature recorded in various aestivation habitats of *Lissemys punctata*.

hours of the day, substratum temperatures were similar in different habitats (i.e. 29°C). However, substratum temperatures in open habitat (drying marsh) rose steadily reaching a peak (48°C) at 1500 hrs and remained above 45°C till 1800 hrs. (Fig. 1). On the other hand, under bushes, the substratum temperature reached a peak of 40°C and never exceeded the atmospheric temperature (Fig. 1). It is reported that the Maximum Critical Temperature (MCT, i.e. the thermal point at which locomotory activity becomes disorganised and leads to death) for Trionychid turtles is 40°C (Hutchinson 1982). Hence, habitats with cover are better for aestivation and in the present case it is bushes, as the temperature never exceeded 40°C. However, turtles were observed aestivating in harsher habitats such as grass. The present observations show that the wild *Lissemys punctata* has a considerably higher temperature tolerance.

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REFERENCES

- AUFFENBURG, W. (1981): Behaviour of *Lissemys punctata* (Reptilia: Testudinata, Trionychidae) in a drying lake in Rajasthan, India. *J. Bombay nat. Hist. Soc.* 78(3): 487-494.
- BENNETT, D.H., J.W. GIBBONS & J.C. FRANSON (1970): Terrestrial activity in aquatic turtles. *Ecology* 51(4): 738-740.
- BHUPATHY, S. (1990): Observations on the food of the Ganges-softshell turtle, *Trionyx gangeticus* in Keoladeo National Park, Bharatpur. *J. Bombay nat. Hist. Soc.* 87(3): 460-461.
- BHUPATHY, S. & V.S. VIJAYAN (1989): Predation on the Indian flapshell turtle (*Lissemys punctata*) in Keoladeo National Park, Bharatpur, Rajasthan. *Proc. Nat. Symp. anim. Behav.* In: Behaviour, Patel, B.H. (Ed.), Sir P.P. Institute of Science, Bhavnagar: 27-33.
- DANIEL, J.C. (1983): The Book of Indian Reptiles. Bombay Natural History Society, Bombay. 141 p.
- DAS, I. (1991): Colour guide to the turtle and tortoise of the Indian subcontinent. R & A Publishing Limited. 133 p.
- GREGORY, P.T. (1982): Reptilian hibernation. In: Biology of Reptilia, Vol. 13, C. Gans and F.H. Pough (Eds.), Academic Press, London. 345 p.
- HUTCHINSON, V.H. (1982): Thermoregulation. In: Turtles Perspectives and Research, M. Harless and H. Morlock (Eds.), John Wiley & Sons, New York: 207-228.
- SEIDEL, M.E. (1978): Terrestrial dormancy in the turtle *Kinosternon flavescens*: Respiratory metabolism and dehydration. *Comp. Biochem. Physiol.* 61 A: 1-4.
- VIJAYAN, V.S. (1987): Vertebrate fauna of Keoladeo National Park, Bharatpur (Contribution 1). Bombay Natural History Society, Bombay. 27 p.
- VIJAYAN, V.S. (1991): Keoladeo National Park Ecology Study. Final Report, Bombay Natural History Society, Bombay. 337 p.